

We claim:

1. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane for use in a membrane electrode assembly (MEA), comprising the step of depositing at least one catalyst layer directly onto a substrate by passing reactants included in a carrier gas through an electrical discharge at atmospheric pressure, wherein said substrate is selected from the group consisting of a polymer membrane, a membrane formed of carbon cloth, and a membrane including carbon particles.
2. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the deposition is carried out without adding a noble gas to the carrier gas.
3. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the reactants are passed through a nozzle containing parallel electrode plates for generating said discharge.
4. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the reactants are passed through a nozzle

containing coaxially-arranged electrodes for generating said discharge.

5. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the reactants are passed through at least one nozzle for generating said discharge, and said nozzle is scanned over said membrane.
6. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the reactants are passed through at least one nozzle for generating said discharge, and said membrane is advanced beneath said nozzle.
7. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the substrate is a polymer electrolyte membrane (PEM).
8. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 7, wherein the PEM is made of an acrylic based polyelectrolyte/fluoropolymer blend.
9. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 7,

wherein the PEM is made of a polyhydrocarbon-based sulfonic acid.

10. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the PEM is made of Nafion® and Aciplex®.
11. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the substrate includes carbon cloth.
12. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the substrate includes carbon particles.
13. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the catalyst layer includes a platinum catalyst.
14. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the catalyst layer includes a platinum alloy catalyst.
15. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 14, wherein the catalyst is a platinum alloy that includes

binary and ternary alloys using metals from columns 4-11 of the periodic table.

16. A method of manufacturing a proton-conducting cation-exchange electrolyte membrane as claimed in claim 1, wherein the step of depositing said at least one catalyst layer comprises the step of depositing multiple catalyst layers.